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ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

INDEXED

PROJECT NO. 5 - CREW FATIGUE RESEARCH

Report On

Sub-Project No. 5-1, Adequate Head Room in Tanks

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Project No. 5-1

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November 27, 1942

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ARMORED FORCE MEDICAL RESEARCH LABORATORY
Office of the Commanding Officer
Fort Knox, Kentucky

Project No. P5-1
File No. 741-3
470.8

November 27, 1942

ADEQUATE HEAD ROOM IN TANKS

1. PROJECT: Adequate Head Room in Tanks.

a. Authority - Letter, Commanding General, Headquarters Armored Force, Fort Knox, Kentucky, 400.112/6 GNOHD, dated September 24, 1942.

b. Purpose - To determine the sitting heights of Armored Force personnel and to compare these with existing head clearances in tanks. Sitting posture is a significant factor in fatigue.

2. DISCUSSION:

a. The sitting heights of 541 men from the 1st Battalion, Armored Force Replacement Training Center were measured with the men sitting erect on a flat table. Attached histogram (inclusions I & II) gives the actual distribution. Statistical analysis shows this group to be an adequate sample from which to draw conclusions.

b. The thickness of the crash helmet at the vertex was determined and found to vary, depending upon the helmet design, from one-half ($\frac{1}{2}$) to one and one-half ($1\frac{1}{2}$) inches.

c. The maximal distance between the cushion of tank seats and the overhead closed hatch or armor plate has been called net head room. See attached inclusion III.

d. The height of each man is increased by the distance from the top of his head to the top of his helmet. There is a slight and variable compression of the seat cushions. There is an indeterminate stoop in each individual which will tend to decrease the space needed for him. However, he must sit nearly erect to operate his periscope efficiently. The vertical adjustability of the periscope is small, the range of men's heights relatively larger; therefore, vertical seat mobility should be such as to make it possible for all sizes of men to adjust themselves comfortably to their periscopes and still not be touching the roof of the tank.

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3. CONCLUSIONS:

- a. The range of sitting heights of 541 soldiers taken at random from the Armored Force Replacement Training Center, 1st Battalion, is from $32\frac{1}{2}$ inches to $40\text{-}3\frac{3}{4}$ inches.
- b. The mean sitting height is 36 ± 0.866 inches.
- c. Approximately one and one-half ($1\frac{1}{2}$) inches is added to this height in each instance by the crash helmet.
- d. Inclusion IV shows the available seat space in the driver's compartment of the M-5 light tank. It has been determined that the tank can be driven satisfactorily if the maximum required head room is made available. A major change in seat design is necessary to effect this change. Inclusion IV also indicates the position and height adjustability required in such a re-designed seat.
- e. Improper seat heights result in cramped positions, increased fatigue and decrease the combat efficiency of men.
- f. Inclusion VII shows the per cent of men accommodated by varying degrees of head clearance both with and without crash helmets of $1\frac{1}{2}$ " thickness. Recent reports indicate that the helmet is perhaps unnecessary. The Armored Force Board is testing a helmet of considerably less thickness.
- g. An 8" adjustment is required to cover the total range of subjects in either the high or the low position, with or without helmet.
- h. Forward and backward adjustment should be retained.
- i. The feature of a two-position change is good since it requires a minimum of time in changing from the "open" to the "buttoned up" position. Additional adjustment to fit the individual is also required.
- j. Since the high and low ranges overlap (see inclusion IV) it might be possible to install an adjusting arrangement similar to that in the turret seats of the new M-5 light tanks which moves thru the total range by small increments.

4. RECOMMENDATIONS:

- a. These basic data be passed on to the Division of Tank Design, and Ordnance Department, with the recommendation that proper seat heights be provided in all future models.
- b. That tank manufacturers be requested through proper channels to provide adequate clearance for men in the seats of new tanks now in production.

c. That the degree of elevation and lowering of the seats be related to the known facts about the sitting heights of men here included.

d. That tank seat design be facilitated by excluding from all future tank crews the upper and lower 5% of men. The resultant acceptable range of sitting heights then becomes 34" to 38 $\frac{1}{4}$ ". The exclusion of 10% of men results in diminishing the requirement for seat vertical adjustability at either the high or low position of 50%.

e. Recommend that the Division of Tank Design, Ordnance Department, and the Armored Force Medical Research Laboratory collaborate in the design of proper seats to replace those which do not permit adequate headroom in existing tanks. It is apparent that such an alteration cannot readily be made in the field and the practicability of making a substitute seat should be seriously considered.

7 Inclusions

Reported by:

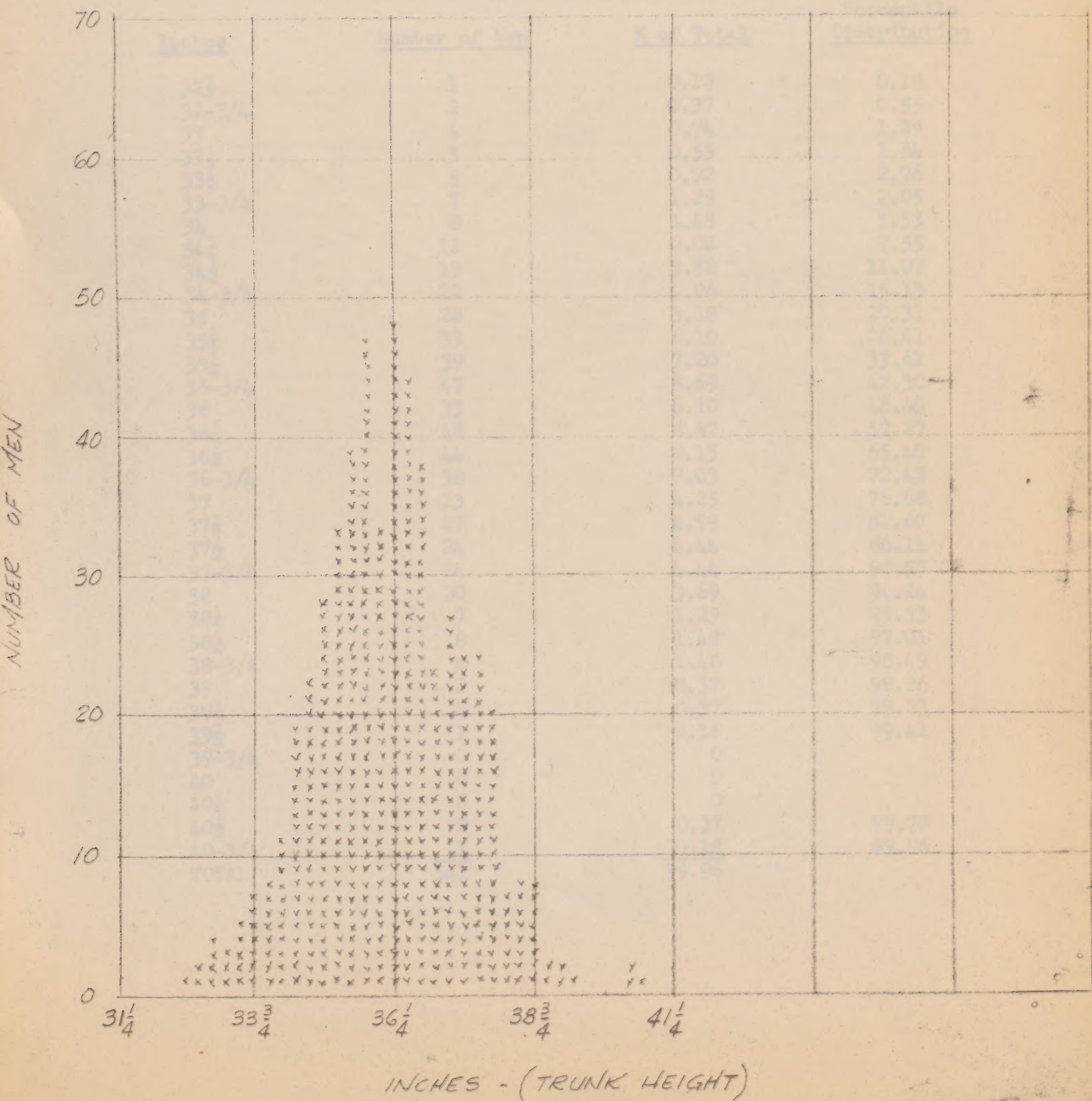
Captain W. F. Ashe
Captain L. B. Roberts
Major E. A. Blair

APPROVED Willard Machle

WILLARD MACHLE,
Lt. Col., Medical Corps
Director of Research

INCLUSION I

DISTRIBUTION OF SITTING HEIGHTS OF MEN



INCLUSION II

Sitting Height Data

<u>Inches</u>	<u>Number of Men</u>	<u>% of Total</u>	<u>Percentile Distribution</u>
32 $\frac{1}{2}$	1	0.18	0.18
32-3/4	2	0.37	0.55
33	4	0.74	1.29
33 $\frac{1}{2}$	3	0.55	1.84
33 $\frac{3}{4}$	5	0.92	2.76
33-3/4	7	1.29	2.05
34	8	1.48	5.53
34 $\frac{1}{4}$	11	2.02	7.55
34 $\frac{1}{2}$	19	3.52	11.07
34-3/4	22	4.06	15.13
35	28	5.18	20.31
35 $\frac{1}{4}$	33	6.10	26.41
35 $\frac{1}{2}$	39	7.20	33.61
35-3/4	47	8.69	42.30
36	33	6.10	48.40
36 $\frac{1}{4}$	48	8.87	57.27
36 $\frac{1}{2}$	44	8.13	65.40
36-3/4	38	7.03	72.43
37	23	4.25	76.68
37 $\frac{1}{4}$	27	4.99	81.67
37 $\frac{1}{2}$	24	4.44	86.11
37-3/4	24	4.44	90.55
38	20	3.69	94.24
38 $\frac{1}{4}$	7	1.29	95.53
38 $\frac{1}{2}$	8	1.48	97.01
38-3/4	8	1.48	98.49
39	2	0.37	98.86
39 $\frac{1}{4}$	2	0.37	99.23
39 $\frac{1}{2}$	1	0.18	99.41
39-3/4	0	0	
40	0	0	
40 $\frac{1}{4}$	0	0	
40 $\frac{1}{2}$	2	0.37	99.78
40-3/4	1	0.18	99.96
TOTAL	<u>541</u>	<u>99.96</u>	

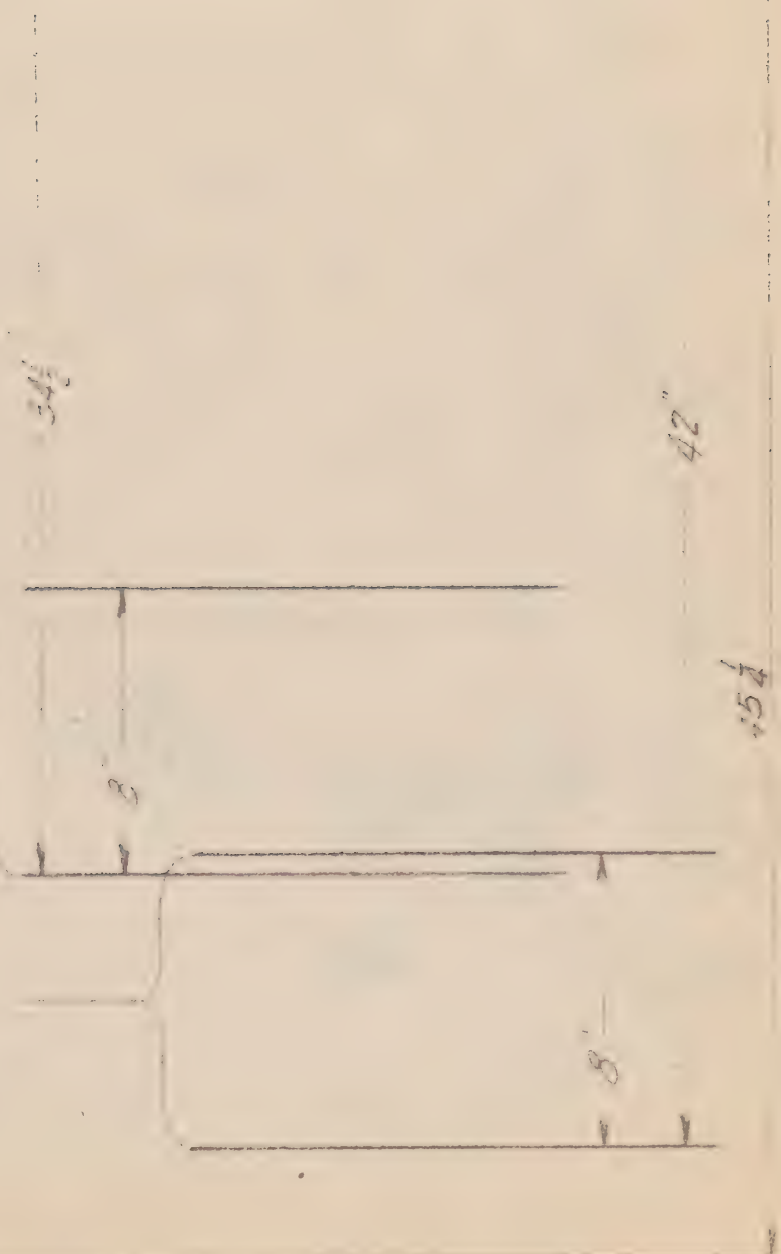
INCLUSION III

NET HEAD ROOM

Position	M - 5 Light	M-4 A-2 Medium	M-4 A-3 Medium	M-4 A-4 Medium
Driver - Lowered	35 $\frac{1}{4}$	36 $\frac{1}{2}$	37 $\frac{1}{2}$	35-7/8
Ass't. Driver - Low	35 $\frac{1}{4}$	36	36-5/8	36 $\frac{1}{4}$
Tank Comd'r. - Low	34	40-3/8	40-3/4	40 $\frac{1}{4}$
Gunner - Lowered		37-3/4	40 $\frac{1}{4}$	37 $\frac{1}{2}$
Gunner - Raised		34 $\frac{1}{4}$	40 $\frac{1}{4}$	34
Leader		35 $\frac{1}{2}$	34-7/8-38 $\frac{1}{4}$	35 $\frac{1}{2}$
Leader - Lowered	33 $\frac{1}{2}$			
Leader - Raised	25			

Line of sight - open door

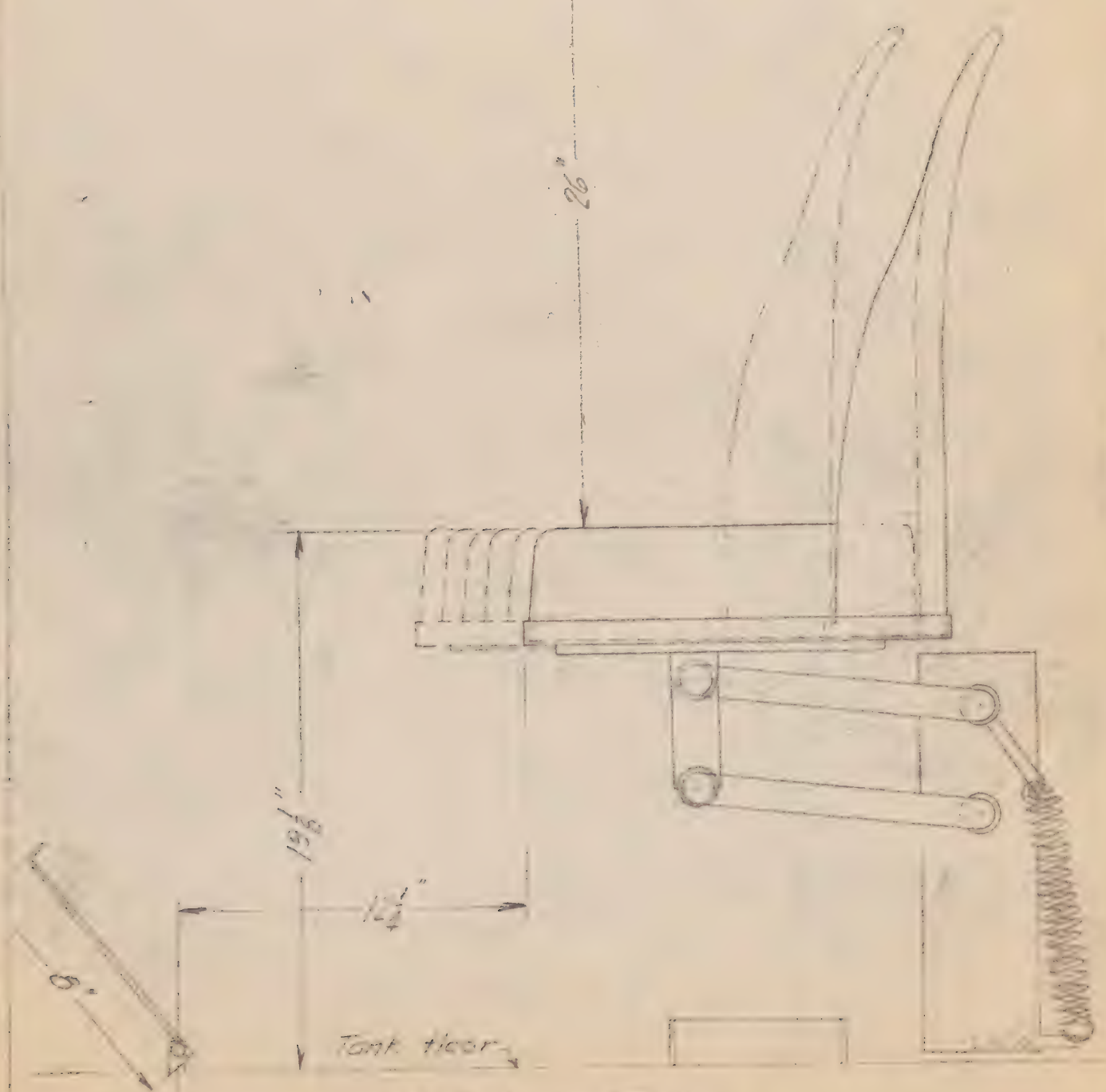
1 inch closed



M-5 LIGHT TANK

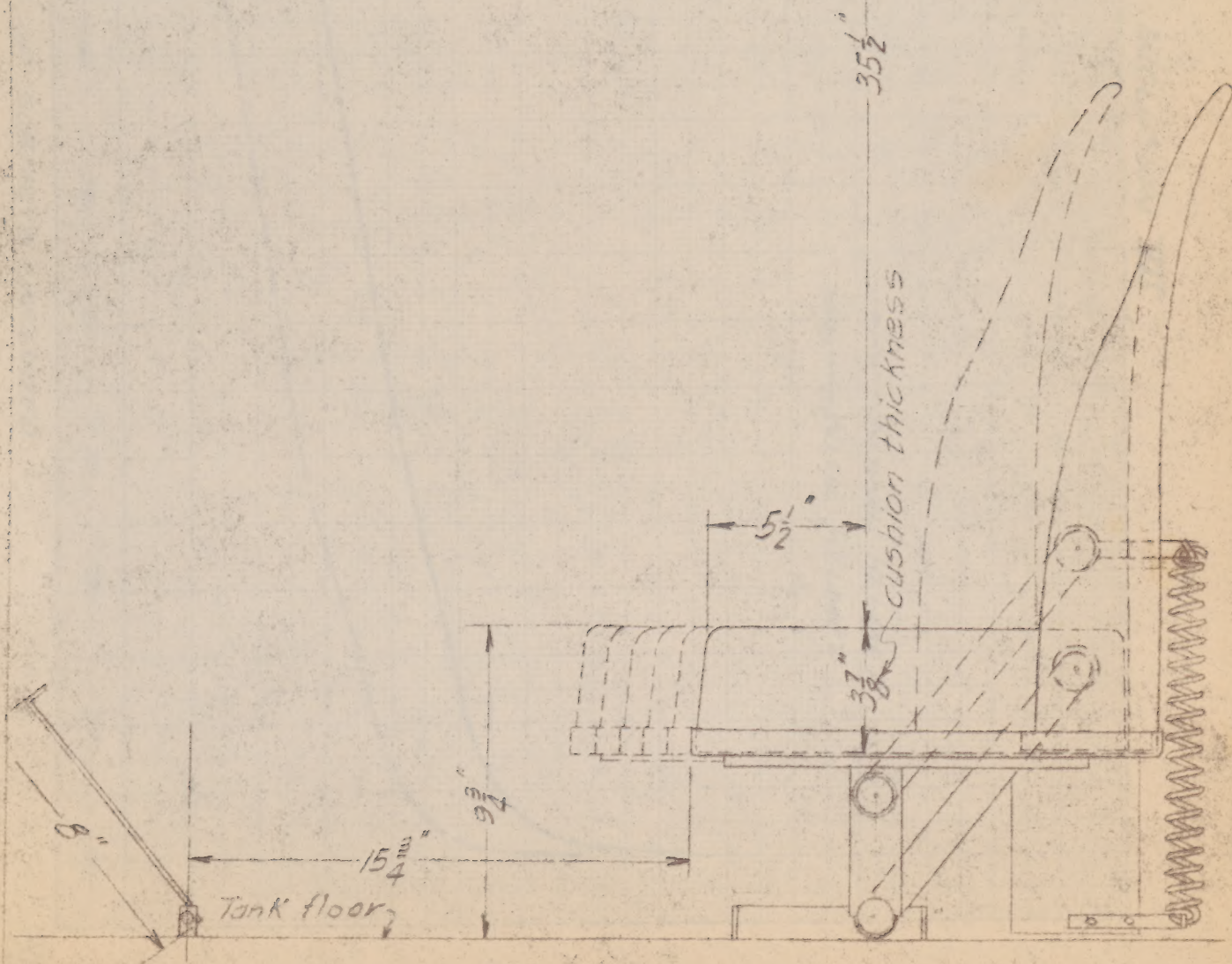
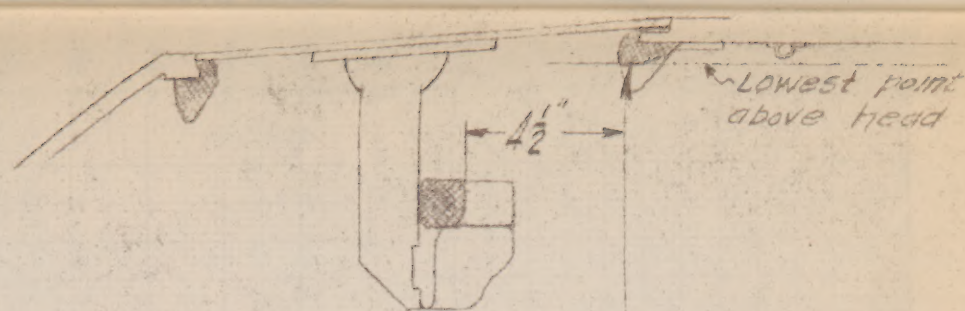
INCLUSION IV

26" 10" - latch of door



M-5 LIGHT TANK

INJECTION V



M-5 LIGHT TANK

INCLUSION VI

HEAD CLEARANCES - INCHES

INCLUSION VII

PERCENTAGE OF SUBJECTS INCLUDED

